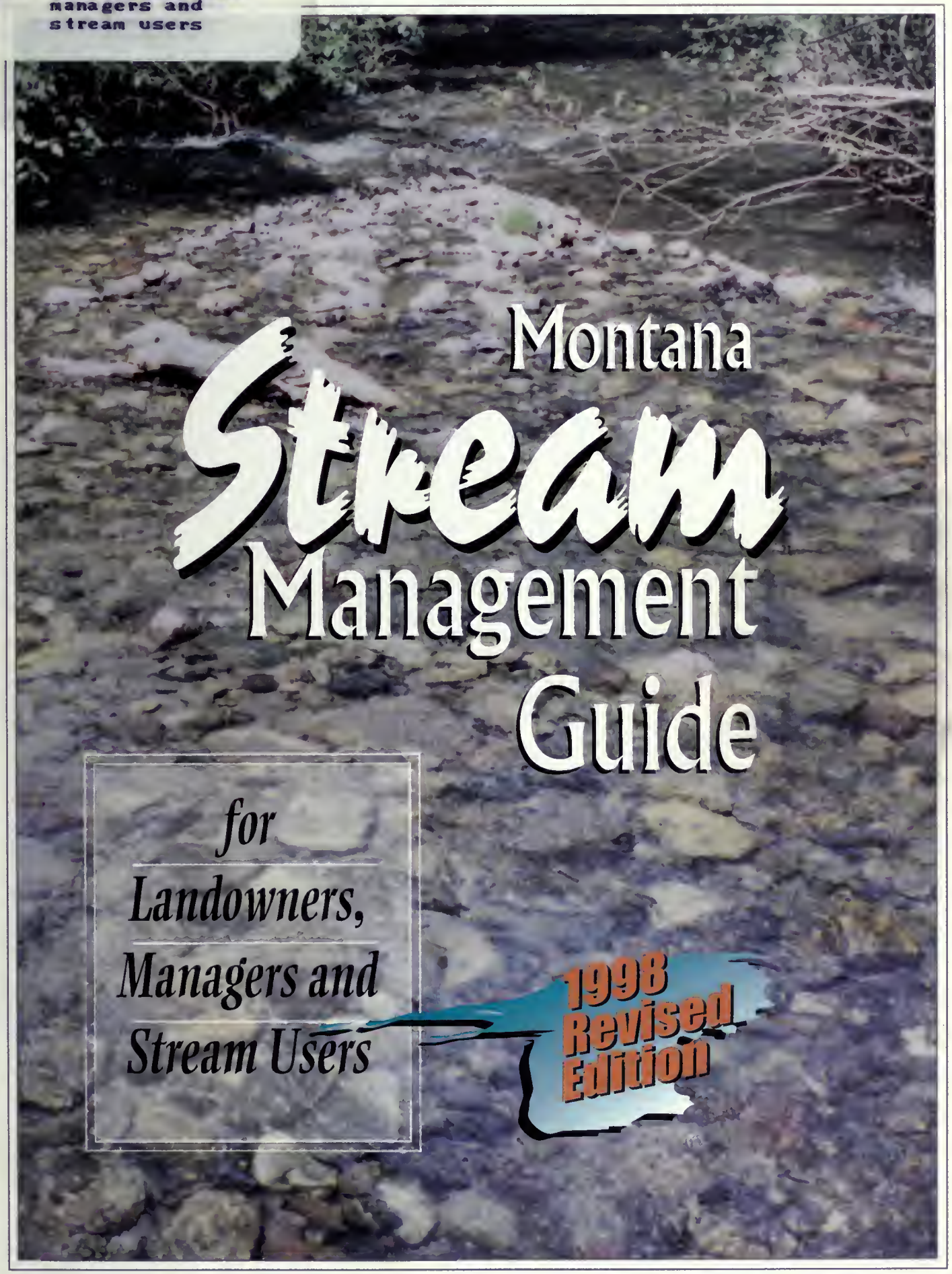


CONTENTS

Acknowledgments

COOPERATIVE FUNDING

Montana Fish, Wildlife & Parks

Montana Department of Environmental Quality

Montana Department of Natural Resources & Conservation

Montana Riparian & Wetland Association

U.S. Environmental Protection Agency

U.S. Forest Service Northern Region

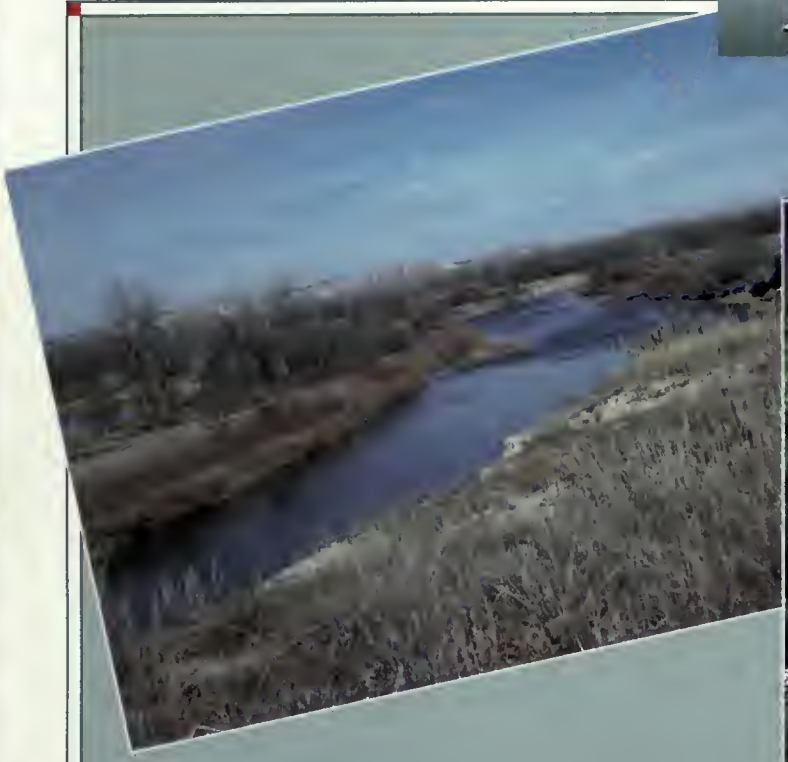
PROJECT SPONSORS

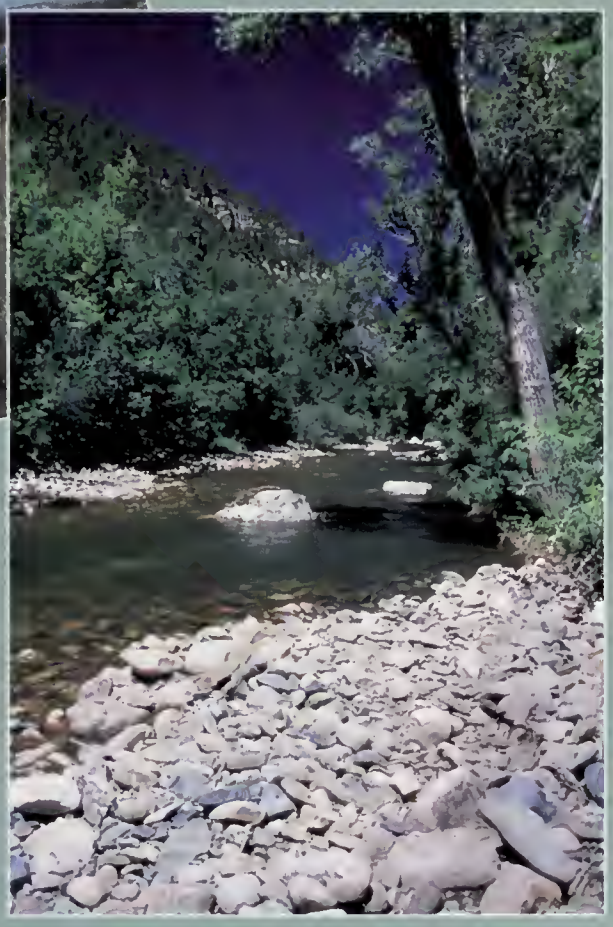
Montana Association of Conservation Districts

Montana Department of Environmental Quality

April 1998

Introduction





Montana's streams vary with the landscapes they flow through—some streams tumble down from high mountain valleys through narrow canyons, others wind lazily through wide valleys and across the plains. As you start to recognize and understand stream types, you will see that different streams or reaches of the same stream respond differently to the same activity, depending on their natural characteristics.

Streams link Montana's mountains and plains, public and private lands, and upstream and downstream neighbors. People can make sound management decisions if they understand how streams work. This guide provides helpful background information for landowners and managers, resource professionals, state and local decision-makers, recreationists, and others interested in streams.

All Montanans are affected by how streams are managed—whether for agricultural, domestic, or industrial uses or for our enjoyment of wildlife, fisheries, or water-related recreation. Flowing water is a shared and limited resource which requires cooperative management among many users and interests. Good stream management makes good $ense. Healthy, stable streams are the most economical and productive for all.

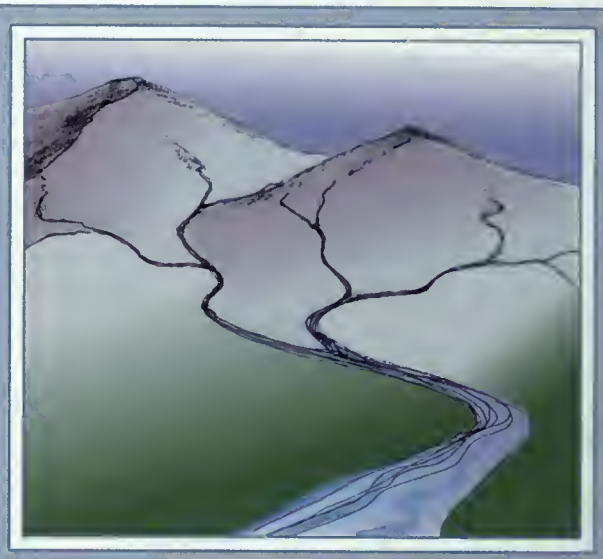
In Section One, "About Streams," you'll learn about the characteristics and behavior of healthy streams. Section Two, "About Restoration," discusses your role in management and restoration decisions, what permits you'll need, and which agencies to contact. Section Three, "Working with Streams," focuses on specific examples of stream problems that you might encounter.

About Streams

What is a Watershed?

A watershed is the total land area being drained by a particular stream or river.

Montana has 16 major watersheds (also called river basins), which are pictured below. These watersheds contain many, many smaller watersheds.

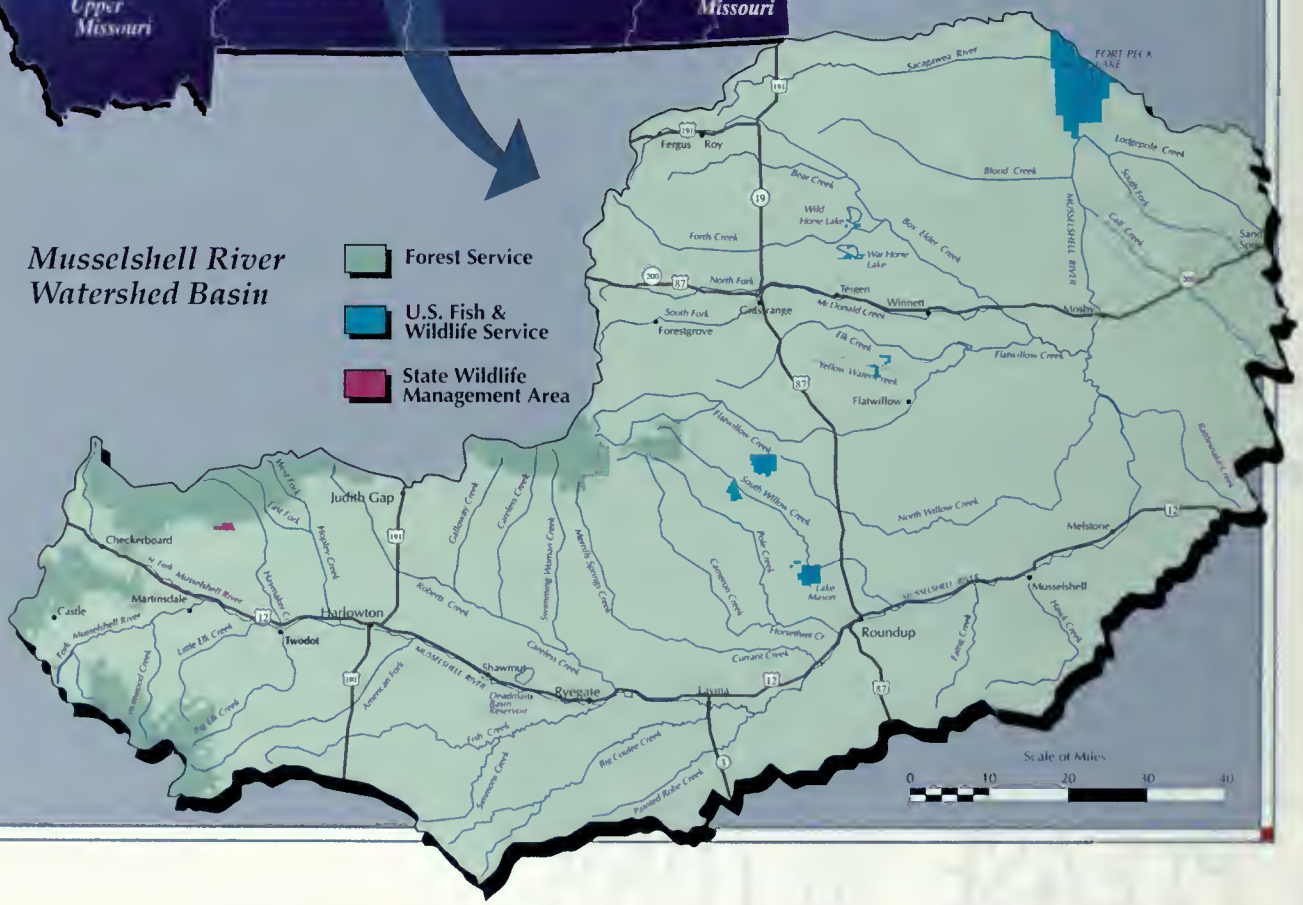


Montana's Major Watershed Basins

Many smaller watersheds, such as the Musselshell River Basin shown below, make up the huge Missouri River watershed.

All streams within a watershed work together to move water and sediment downstream.

Musselshell River Watershed Basin



Watersheds, Geology, and Climate

Stream channels are formed by the flow of water and the load of sediment they carry. The amount of water and sediment moving through a watershed depends on climate and geology.

Climate determines:

- amount of rain and snow, and the timing of runoff
- rate of evaporation
- type of vegetation
- rate of groundwater recharge
- rate of erosion
- how quickly bedrock weathers to soil

Geology determines:

- rate of erosion
- potential for sedimentation
- stream bank material
- permeability and porosity of soils
- aquifer depth and recharge rate
- water chemistry and biological productivity

Peak flow, the greatest flow in a stream, typically occurs in western Montana during late spring and early summer when snow melts in the mountains. In eastern Montana, some streams experience high flows after intense rainstorms in spring and summer.

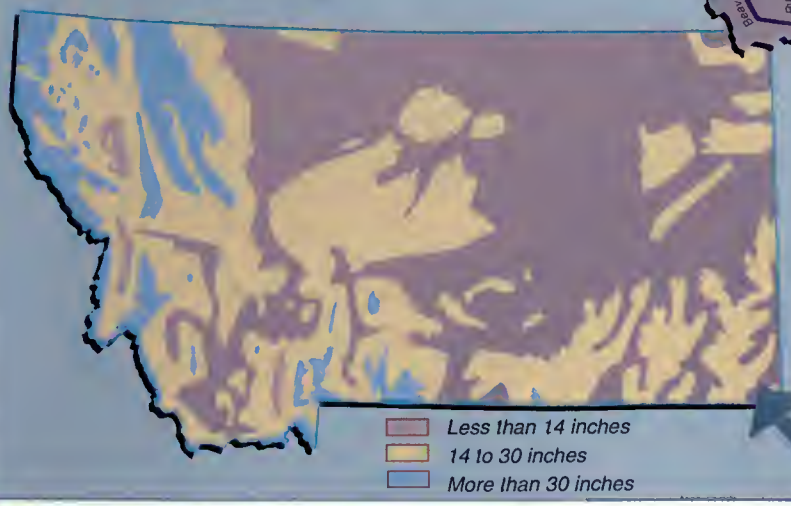
Base flow, the lowest flow in a stream, typically occurs in western Montana from late summer through the winter. Flows may go entirely below ground during dry periods.

Precipitation in Montana falls unevenly—most falls in the western third of the state, west of the Continental Divide. Because of this, more water flows out of the state in the Clark Fork River than in the Missouri River, which collects water from the eastern two-thirds of the state.

Average Annual Runoff

Width of stream line corresponds to top width of channel. Mean annual discharge, in thousands of cubic feet per second, is represented by channel cross section in blue.

Average Annual Precipitation



Forested, mountainous watersheds in northwestern Montana receive 60 to 100 inches of precipitation per year and have more perennial streams; grassy plains watersheds of eastern Montana, which receive 8 to 12 inches of precipitation, have more intermittent and ephemeral streams.

Watersheds, Geology, and Climate

Montana's streams are as diverse as the landscapes through which they flow—from the forested mountains to the grassy plains.

When a stream flows through a steep, narrow valley, it runs relatively straight and fast, cascading and scouring out pools.

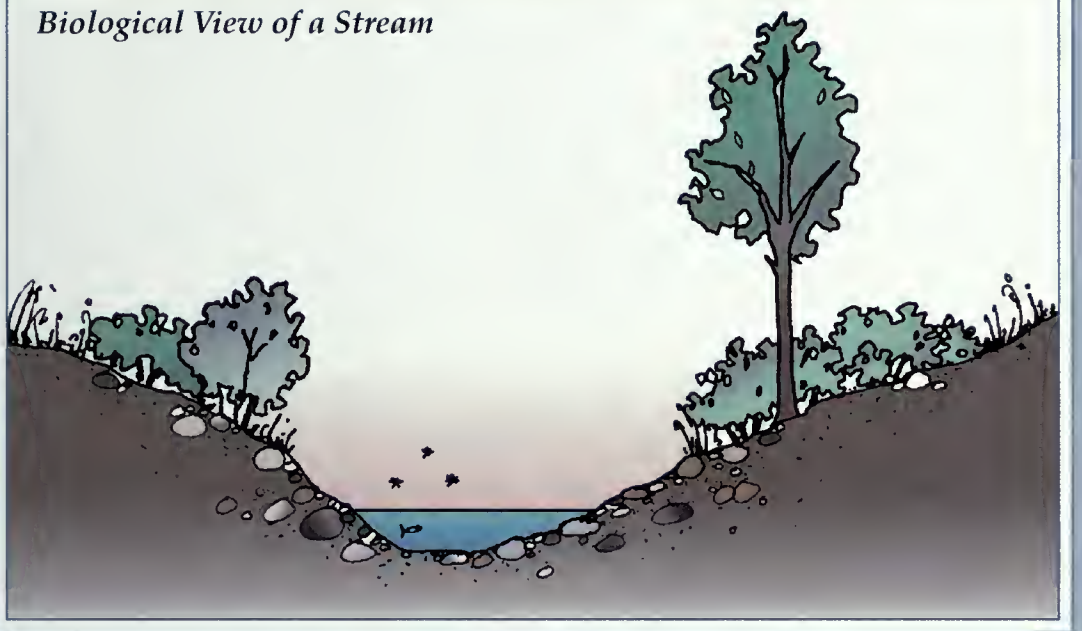
Some streams flow slowly through wide, flat valleys. Wetlands and riparian areas form along the banks and occupy floodplains, creating rich streamside habitat. Stream banks are of finer-textured soils, hold more water, and may support a greater diversity of vegetation than high mountain streams.

Features

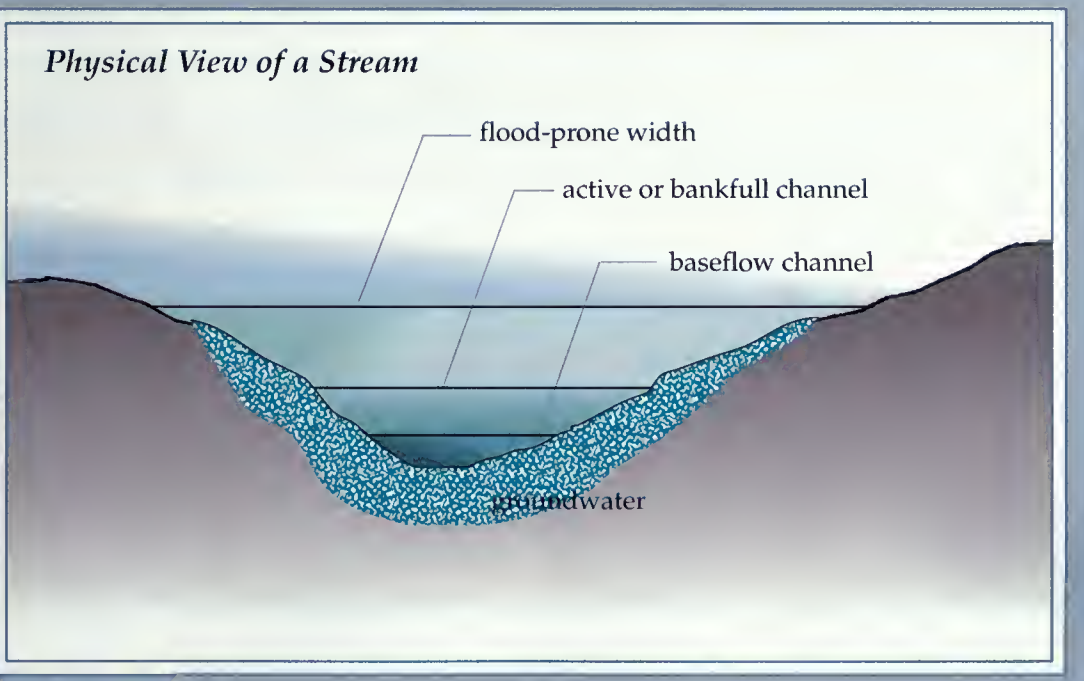
Components of a Healthy Stream System

- stable stream channel
- active floodplain
- groundwater
- healthy riparian (streamside) vegetation
- high quality waters

Biological View of a Stream



Physical View of a Stream



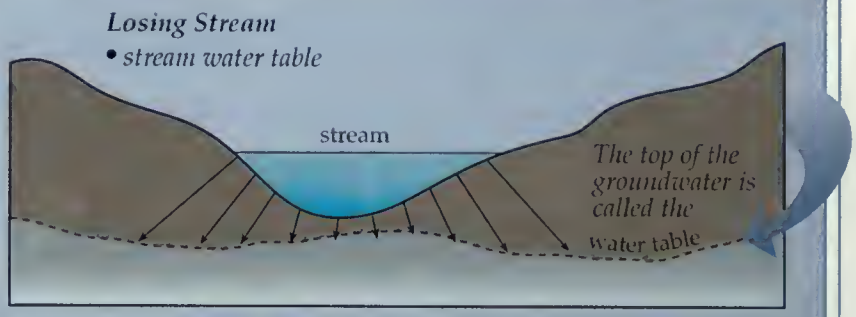
Features

Groundwater is the water that seeps through the spaces between soil particles and flows into aquifers.

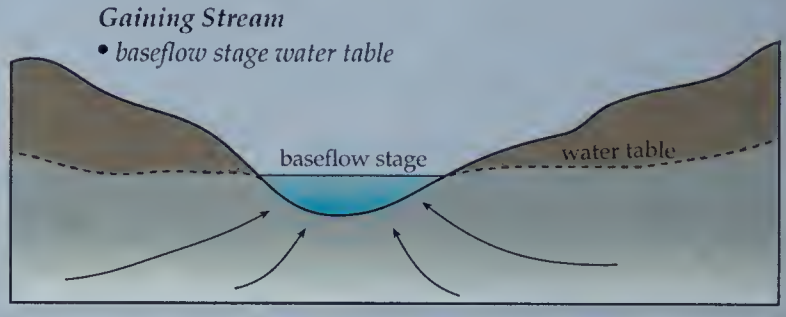
Aquifers are saturated zones of sand, gravel, or fractured bedrock underlying the valley.

Porosity is the volume of the spaces or pores between particles in an aquifer. It varies with the type of material present and determines how much water the aquifer can hold.

Permeability is the rate of water movement through the soil or aquifer. It is much faster in materials with large pores, such as gravels and sand, than in materials with small pores, such as clays.



*During dry periods, groundwater may **RECEIVE** water from the stream.*



*During wet periods, groundwater **ADDS** water to the stream.*

Gravity is the driving force behind rivers, causing water to flow downhill, to seep into streams when the water table lies above the streambed, and to seep into the ground.

Healthy Riparian Areas ...Healthy Fish Populations

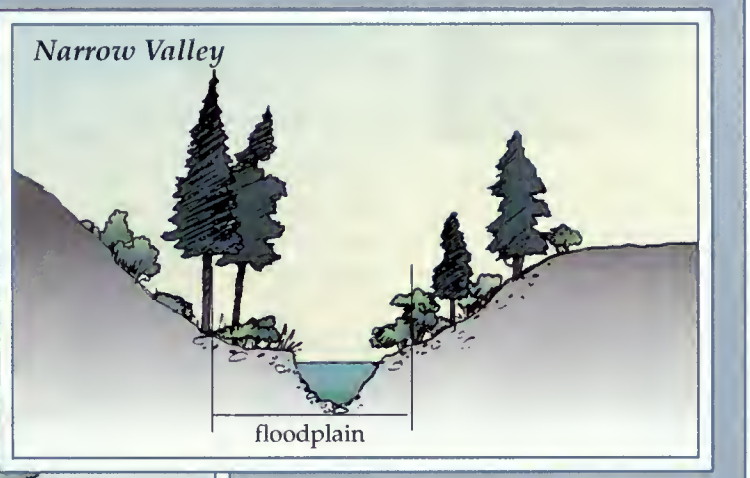
In a healthy riparian area, there is an interrelationship between vegetation, pools and riffles, and fish. Working together, these components produce a healthy environment for fish and protect water quality.

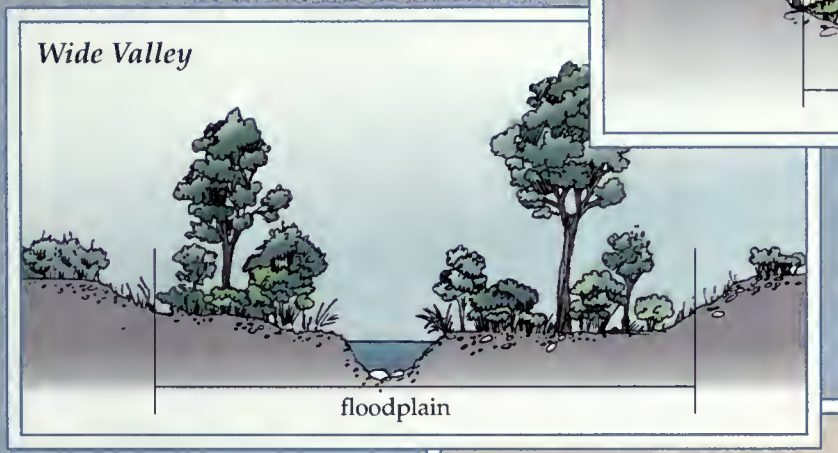
Floodplains

Flooding is a natural stream process. A floodplain—land next to a stream where water overflows during floods—is an important part of the stream system.

The Role of Floodplains

- Spread out and slow flood waters, reducing their erosive force.
- Slow water enough so it can seep into soil, recharge aquifers, and slowly return to stream.
- Filter sediment that settles from the water, building deep, fertile soils.





The Biological Richness of Riparian Areas and Streamside Wetlands

1. Riparian areas contain a diversity of plants.
2. They provide wildlife with:
   - corridors for migration
   - cover from weather and predators
   - breeding, resting, nesting, and foraging areas

What's Your Stream's Personality?

These characteristics determine many stream types, each with its own "personality."

1 *Channel and bank materials*
2 *Sinuosity*
3 *Channel gradient*
4 *Floodplain*
5 *Channel shape*

Other important stream characteristics not illustrated here:
6 *Flow timing and amount*
7 *Amount and size of sediment*

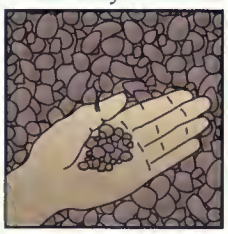
By understanding the combination of characteristics that make up your stream's personality, you can determine appropriate management practices. Changing any of these characteristics without careful planning can cause unwanted changes in the stream (see pages 14-17 and 22-30).

1 *What's the most common material making up the channel and bank?*

Silt/Clay *smooth between fingers*

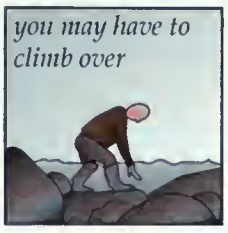
Sand *feels gritty*

Gravel *fits in hand*



Cobble
you can stand on

Boulder
you may have to climb over



Bedrock
solid rock

Channel and bank materials are critical characteristics of a stream.

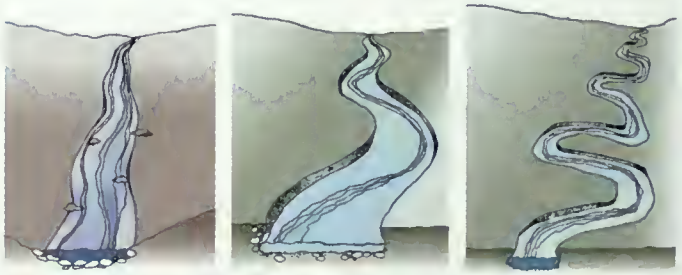
They determine:

- sensitivity to disturbance and potential for erosion
- recovery potential
- ability to support vegetation
- role of vegetation in stabilizing stream channels
- amount of channel roughness to slow stream flow and reduce stream energy

2 *How sinuous is the channel?*

Sinuosity refers to the amount of curvature in a stream channel. The increased length of a highly sinuous channel helps to dissipate stream energy. Shorter and straighter channels possess more stream energy and erosion potential.

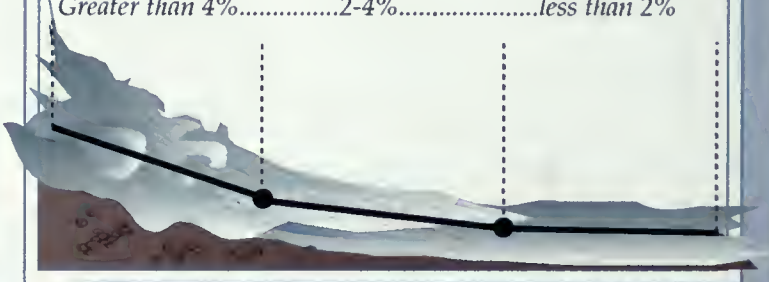
straight *slightly sinuous* *highly sinuous (meandering)*



3 *What is the gradient of the channel?*

The steeper the channel gradient, the greater the water velocity and potential for erosion.

Greater than 4%.....2-4%.....less than 2%



4 *Is a functioning floodplain present?*

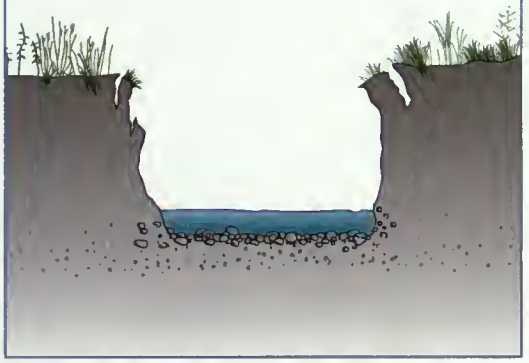
Does your stream overflow its banks every few years? If not, the stream may be changing because of alterations in the watershed. Without a floodplain, the stream's energy is concentrated in the channel during flood flows. This increased energy may either downcut the channel or erode the banks.

To determine the edge of the bankfull channel, which is the beginning of the floodplain, look for:

- top of point bar
- change in vegetation
- slope break
- change in particle size of bank material
- undercuts in the bank
- stain lines or lower extent of lichens on boulders

All of these characteristics influence the personality of your stream under natural conditions. Stream types may be changed by our alterations and activities.

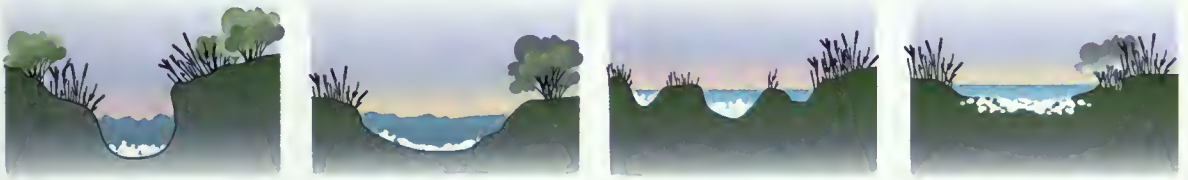
Downcut stream with no floodplain



Stream with functioning floodplain

5 *What is the channel shape?* Channel shape is mostly influenced by:

- quantity of water
- amount and size of sediment
- type of bank and bed material
- gradient/valley slope
- amount and type of vegetation and its associated root mass
- human activities that directly alter channel or watershed



Common channel shapes

How Healthy Streams Work

Now that you know about the features and characteristics of streams, let's think about how a healthy stream works:

- What is it trying to accomplish?
- How does it maintain a balance of water and sediment?
- How does it form a shape?

Streams begin when water accumulates and moves through a watershed. To simulate this action, pile dirt into a hill. Begin squirting water on the hill; you'll see that a stream soon forms. You've eroded a channel in the dirt and created a stream full of energy. Based on the stream's characteristics (see pages 8-9), the stream will use that energy to accomplish two tasks:

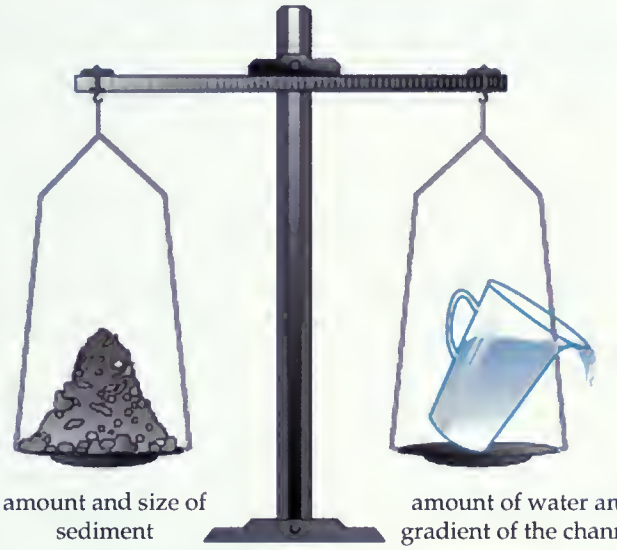
- move water
- carry sediment

Keeping the Balance

In any given reach, a stream constantly adjusts itself. It is balancing the amount of water and gradient of the channel, and the amount and size of sediment.

Any disturbance, either natural or human-caused, will alter this balance. Our activities—such as modifying streams, diverting or adding water, building in floodplains, or removing vegetation—can limit a stream's ability to maintain a balance. An unbalanced stream is an unhealthy stream.

Balance in equilibrium



amount and size of sediment

amount of water and gradient of the channel

Erosion Isn't Always Bad

We often think of erosion as the culprit that degrades streams, but erosion is a natural process. A healthy stream bank may erode a small amount each year. Erosion becomes destructive to streams when it increases above the normal rate. Then it takes land away from wildlife and agriculture, and reduces the water quality that fish and other aquatic life need. (You'll find more information about this under "Floodplains" on page 7; see also page 24.)

Examples of healthy and unhealthy stream types are discussed on pages 14-17; more details about unhealthy types are covered in Section 3, pages 21-31.

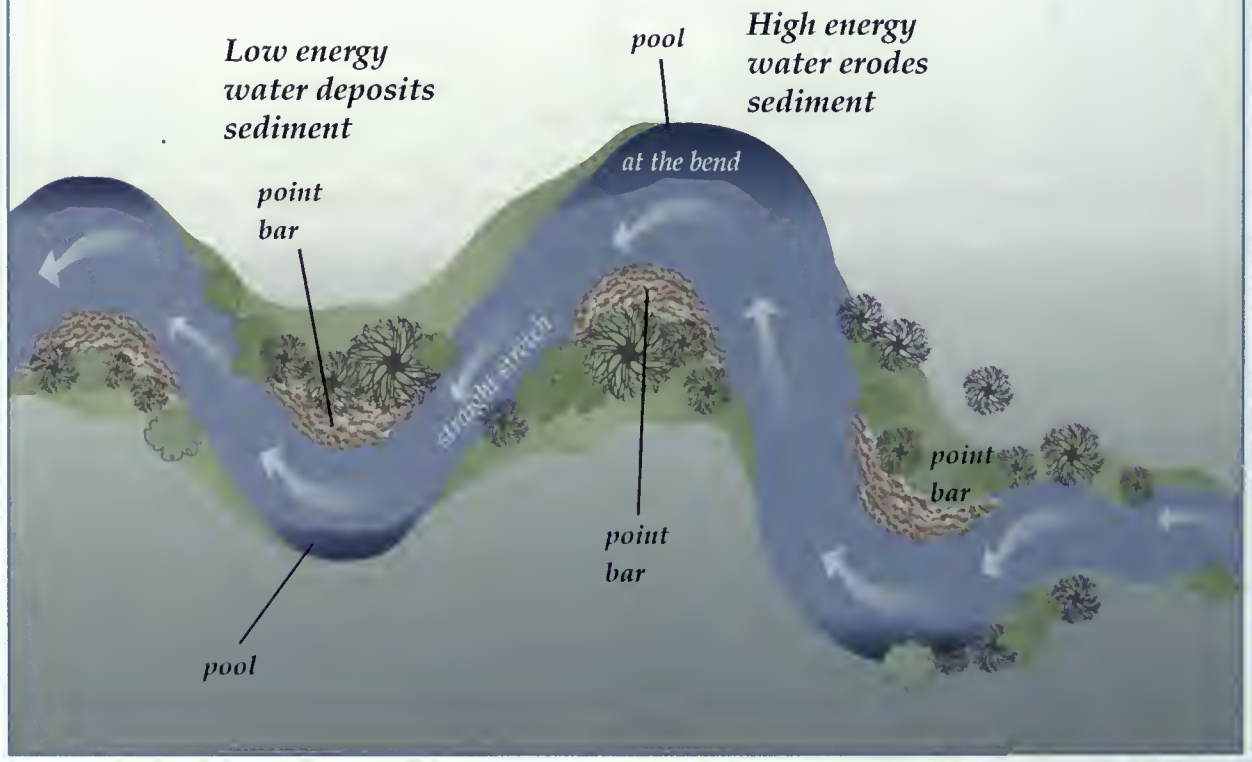
What Shapes A Stream?

As streams move through watersheds, their appearance, shape, and energy change as local conditions change. (Typical types are shown on pages 14-17.) A stream may begin as a rush of water over rocks on a steep slope. Further down the watershed, it may empty onto a wide, flat valley where soft soils erode easily. The stream will migrate across the valley while maintaining its channel shape, gradient, and sinuosity.

1

Forming Meanders

Shifts of energy in a stream will also shift the sediment. When the energy core is against the outside bank (see box 3, next page), it erodes sediment and deposits the material downstream on the inside bend in a point bar. This natural process forms meanders in streams with low gradient.

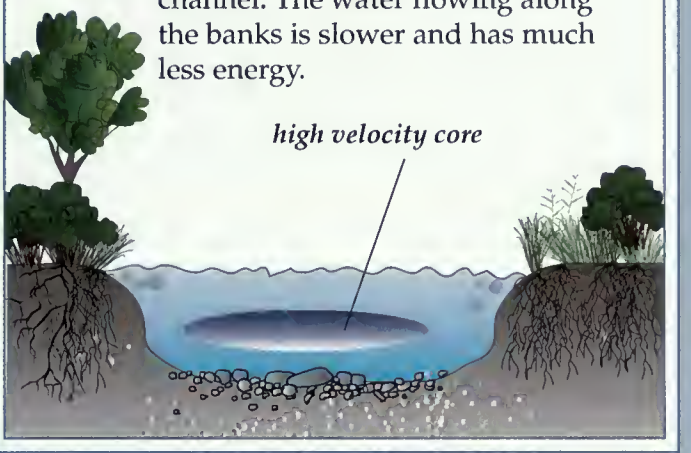


Streams Need Room To Move

Meandering stream channels naturally migrate over time—and you need to allow plenty of room for this migration. Avoid building near a stream, and always consider the flood-plain to be part of the stream. Don't build there!

2 ***Straight Stretch***

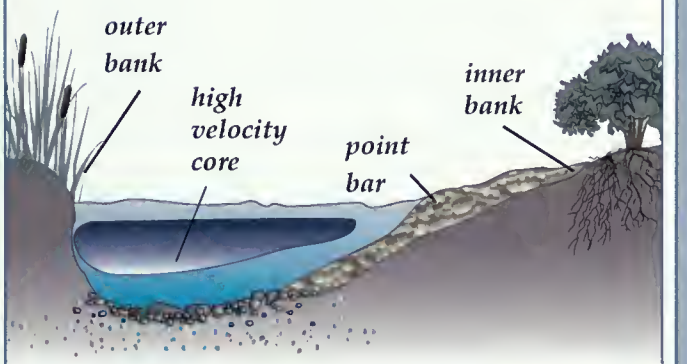
In a straight stretch, the energy focuses in the center of the channel. The water flowing along the banks is slower and has much less energy.



3 ***At The Bend***

As a stream makes a turn, the energy core moves to the outside bank. This shift increases stress on the bank. Slight erosion at this site is normal. Healthy vegetation will protect the bank from severe erosion under most conditions. (See page 6.)

Consider the affect of this shifting energy as you read about a stream's "personality" (pages 8-9) and the different types of streams in Montana (pages 14-17).



Healthy Stream Types

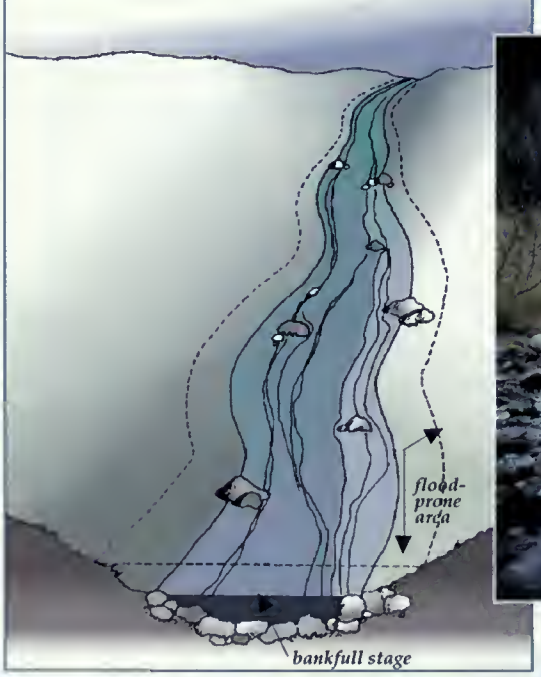
Common in Montana

Mountain Stream

- steep slope (greater than 4%)
- V–shaped valley
- vertical erosion (little horizontal)
- narrow floodplain and riparian area
- narrow, deep channel
- straight to slightly sinuous
- often a series of descending pools

Foothill Stream

- slope 2-4%
- pools and riffles

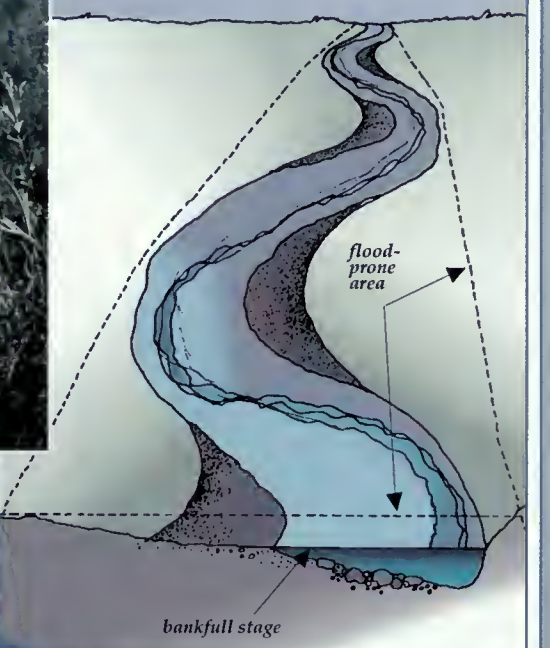


Healthy Stream Types

Common in Montana

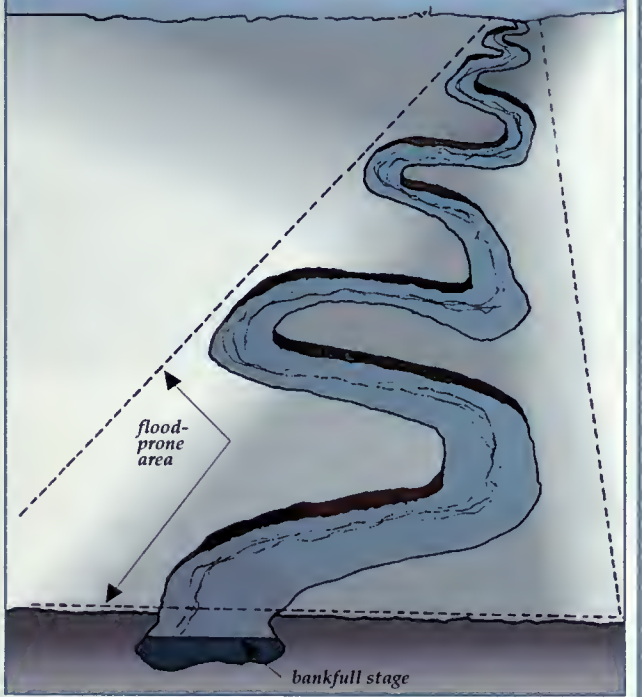
Wide Valley Bottom Stream

- slope less than 2%
- point bars, riffles, pools
- flood flows spread over broad floodplain and riparian area
- sinuous
- wide, shallow
- horizontal (lateral) erosion



Meandering Meadow Stream

- slope less than 2%
- flat-bottomed valley
- narrow, deep, sinuous channel
- little sediment load
- accessible floodplain
- well-vegetated banks

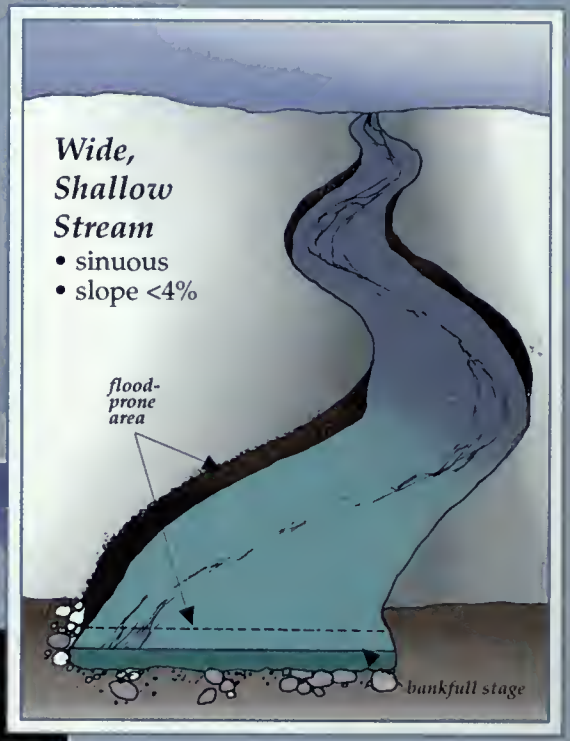


Unhealthy Stream Types

Common in Montana

Some Indicators of Unstable Stream Channels

- channel widening
- unvegetated, eroding stream banks
- channel downcutting
- increased silt/clay on channel bottom
- inability to overflow banks during spring runoff
- increase or decrease in water supply
- increase or decrease in sediment supply



Braided Stream

- slope less than 2%
- multiple shifting channels
- heavy sediment load
- erodes laterally
- wide, shallow
- little aquatic habitat

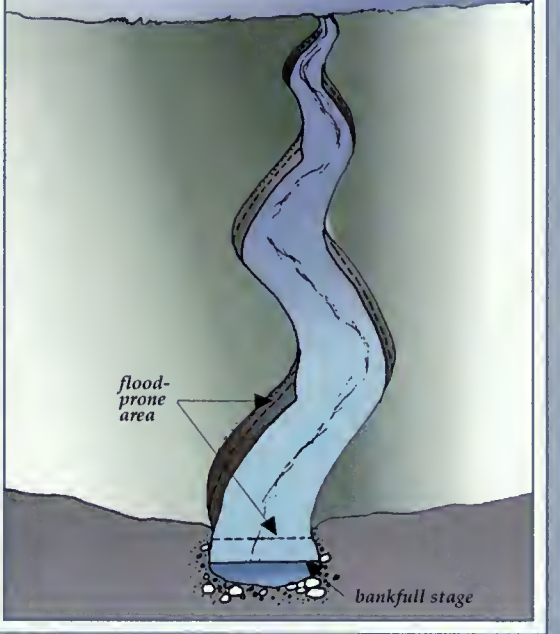
Some braided streams occur naturally, such as in a glacial headwater environment, but they most often result from human activities that contribute excessive sediment to the stream.

Unhealthy Stream Types

Common in Montana

Entrenched/Incised Stream

- slope 2-4%
- gully-shaped channel
- no access to floodplain



Does Stability = Health?

If you're like most stream managers, you'll ask yourself, *"Is my stream stable?"* Instead, ask yourself the more relevant question: *"Is my stream healthy?"* Many healthy streams seem unstable as they react over time to normal erosion and other natural disturbances. A healthy stream is moving both water and sediment in a state of natural balance; in doing so, it provides a rich diversity of plant and animal life.

As you think about your stream's health, ask yourself these questions:

1. Is my stream moving water and sediment in balance?
2. Is my stream accessing the floodplain?
3. Are the banks protected by healthy riparian vegetation with dense, bank-binding roots?
4. Is my stream's sinuosity, gradient, or channel shape changing?
5. What is happening in the watershed and how is that affecting my stream?
6. Is my stream in balance with the surrounding environment?

In the following section, "About Restoration," you'll find out more about evaluating stream health and restoring unhealthy streams.

About Restoration

■ Watershed Planning

Many of the healthy characteristics of this impacted stream have been lost . . .

. . . however, after careful planning, a nearby reach of the same stream has been restored.

Watershed planning begins when citizens of a river basin evaluate the condition of their land and water resources. They then develop a plan to restore or keep the resources in top-notch condition while meeting most social, economic, and ecological needs in the basin.

Steps in watershed planning:

- Form a watershed planning committee that includes a variety of interests and occupations in your basin.
- Hold a public meeting to identify the resource concerns in the basin.
- Form a technical advisory team composed of agencies and organizations that can help you gather information and find solutions.
- Conduct an inventory to determine the total stream miles and condition of critical reaches in the watershed.
- Prepare a plan, reviewing the range of alternatives, setting priorities, evaluating cost efficiency and project effectiveness.
- Present the plan to the public to review and adopt.
- Implement the plan using financial and technical assistance available from a variety of sources.
- Review the plan and progress annually.

Stream restoration is part of watershed planning. If something is "broken" or out of balance on a smaller stream in the watershed, it *may* be fixed by a simple management change, *or* it may require a realigning of channel sections. Think of it like an automobile when something goes awry—the problem could be a broken belt or a blown engine. So before beginning a restoration project, be sure to identify the *cause* of the problem and address that *first*.

Eight Steps To Restore A Stream

To ensure successful restoration, you need to thoroughly plan and carefully implement the restoration. The steps on this page will help you achieve your goals, as will the agencies listed on the next page.

1 *Get to Know Your Stream*

- Your first step is to familiarize yourself with your stream and its combination of characteristics. Take a walk along, or maybe even *in*, your stream.

2 *Assess Your Stream & Streamside Area*

- Identify healthy stream reaches.
- Identify problem areas.
- If necessary, seek assistance from a resource professional.
- Use a stream channel and riparian area monitoring form available from local resource agencies.

3 *Quantify Problems*: For *example, ask*

- How many feet of stream bank are bare of vegetation and eroding?
- How many feet of stream bank contain noxious weeds or species with poor root structure?
- How healthy is the fish habitat? Are pools and riffles adequate for fish reproduction, rearing, and overwintering?

4 *Prioritize Problems to Address*

- Read Section 3 about common stream problems and their solutions.
- Discuss the stream problems with a stream management specialist.
- Determine which problems can feasibly be corrected by *your* actions.
- Which problems need the help of your neighbors and community?

5 *Establish Your Objectives*

- Objectives should be realistic. If you include measurable standards and a workable time frame, you can better gauge your success. For example, you can aim to increase native streambank vegetation by 50 percent in five years.

6 *Develop a Work Plan*

- Evaluate a range of alternatives.
- Compare the costs for different management practices and restoration alternatives.

7 *Implement Your Work Plan*

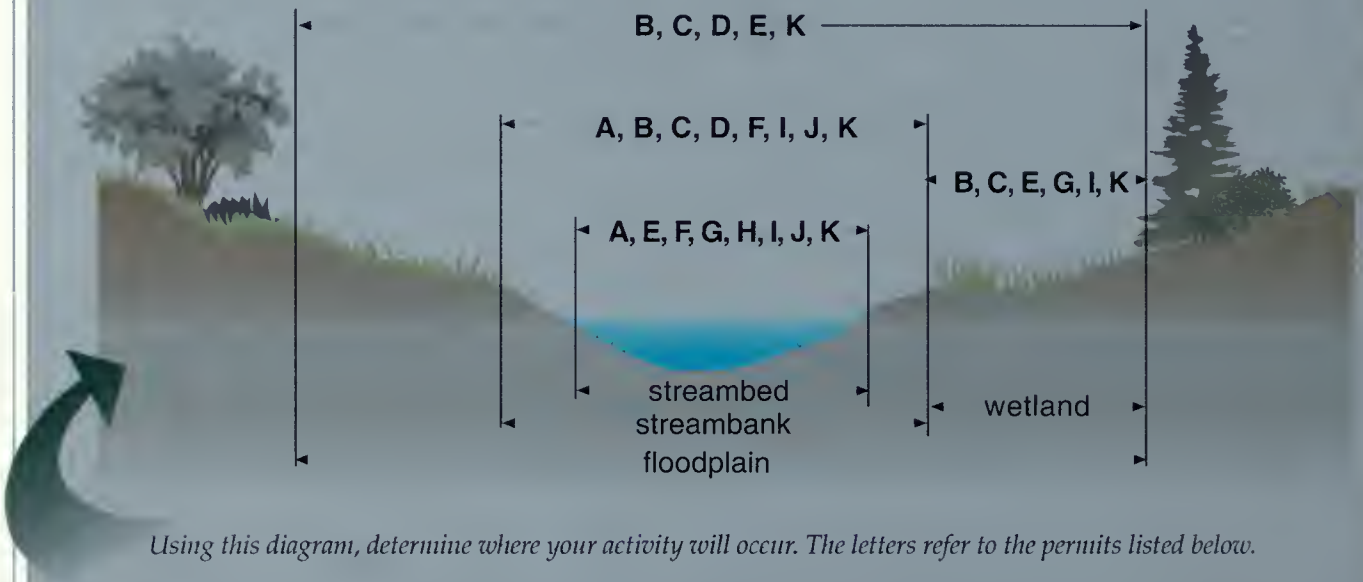
- Obtain all necessary permits.
- Adopt new management practices.
- Improve stream channel stability by actions such as:
  —installing tree revetments
  —planting streamside vegetation
- Seek qualified contractors to assist you.

8 *Monitor the Restoration*

- Annually evaluate whether you are meeting your restoration objectives. Assess the need for modification and maintenance. Share your observations with stream management professionals so that we all learn how to manage and restore streams successfully.

The Permits You'll Need

If you are planning a management activity in or around a stream, you will probably need a permit from a local, state, or federal agency. Use this diagram to determine where your project will take place—streambed, stream banks, wetlands, or floodplain—and what permits you need for activities in that part of the stream. Contact the appropriate government agency for information about acquiring necessary permits. Before issuing a permit, the agency checks to make sure that your plans are technically feasible, have limited or mitigated impacts, and do not affect your upstream or downstream neighbors.



Using this diagram, determine where your activity will occur. The letters refer to the permits listed below.

	Permit	Government Agency	Phone
A	Montana Stream Protection Act (124)	Montana Fish, Wildlife & Parks	406-444-2449
B	Storm Water Discharge General Permits	Dept. of Environmental Quality	406-444-2406
C	Streamside Management Zone Law	Dept. of Natural Resources & Conservation	406-542-4300
D	Montana Floodplain and Floodway Management Act	Dept. of Natural Resources & Conservation	406-444-6610
E	Short-term Exemption from Montana's Surface Water Quality Standards (3A)	Dept. of Environmental Quality	406-444-2406
F	Montana Natural Streambed and Land Preservation Act (310)	Montana Assn. of Conservation Districts and Dept. of Natural Resources & Conservation	406-443-5711 406-444-6667
G	Montana Land-use License or Easement on Navigable Waters	Dept. of Natural Resources & Conservation/ Special Uses	406-444-2074
H	Montana Water Use Act	Dept. of Natural Resources & Conservation	406-444-6610
I	Federal Clean Water Act (Section 404)	U.S. Army Corps of Engineers	406-444-6670
J	Federal Rivers and Harbors Act (Section 10)	U.S. Army Corps of Engineers	406-444-6670
K	Other laws that may apply, depending upon your location & activity	Various agencies	

For more details, request "A Guide to Stream Permitting in Montana" from the Montana Association of Conservation Districts, 501 N. Sanders, Helena, MT 59601; 406–443–5711.

Working with Streams

If you live next to a stream, your streamside management activities can directly affect stream health and function. This section examines some of the most common ways that we impact streams and change their features and behavior.

Most problems can be traced back to something that has changed the supply of water or sediment in the stream or altered the stream channel or banks in some way. We can often lessen the impact through preventive measures or adjustments in our management of the stream. *When making streamside management decisions, you should always practice preventive thinking because stream degradation is much easier and cheaper to avoid than to fix.* You can prevent stream disturbance if you understand stream behavior and the "personality" of *your* stream.

LOOK FOR THIS ALERT—it reminds you to always seek guidance and obtain permits from your local land management agencies before work in or near a stream. Always refer to the chart on page 20 before beginning a project.

■ Riparian & Streamside Vegetation

Maintaining healthy vegetation should be your first priority when managing stream and riparian areas. Stream behaviors, such as channel widening and bank erosion, are influenced by the amount and kind of vegetation on stream banks. Healthy stream banks are covered by deep, densely rooted streamside vegetation that binds soils. Streambank vegetation also creates friction that slows stream flows. Removing vegetation, or replacing it with riprap or cement walls, increases stream velocity and sends more erosive stream energy downstream.

How We Impact Vegetation

- Overgrazing by livestock or wildlife
- Spraying herbicides
- Operating heavy equipment in riparian areas
- Building roads
- Clearcutting streamside areas
- Farming to the edge of a stream
- Allowing invasion of non-native species
- Removing riparian vegetation

Effects of Impacting Vegetation

- Increases bank erosion & failure
- Widens channels; decreases depth
- Disrupts streamside plant communities
- Increases invasion of non-native plants
- Lowers water table
- Makes stream banks more susceptible to livestock trampling and erosion
- Increases water temperature
- Speeds runoff
- Reduces trapping of sediment and other pollutants
- Reduces livestock forage
- Increases bank damage due to icing
- Decreases valuable real estate
- Decreases fish and wildlife cover

Lessening Our Impact

- Do not remove riparian vegetation
- Control noxious plants
- Manage grazing intensity, vary season of use, and provide sufficient rest to encourage plant vigor and regrowth
- Ensure sufficient vegetation during spring runoff or peak flow to protect stream banks, dissipate stream energy, and trap sediments
- Control the timing of grazing to prevent damage to stream banks when they are wet and most susceptible to trampling
- Re-establish native and appropriate non-native plant species

■ Water Quality

Sediment is the number one polluter of streams in Montana. Other pollutants include chemicals, pesticides, herbicides, nutrients, minerals, and salinity. Human-caused changes in temperature, such as warming or cooling, are also considered pollution. All of these pollutants limit the way that water can be used by humans and other life.

How We Impact Water Quality

- *Point source pollution* enters a stream from a known point, such as a discharge pipe, and is usually municipal or industrial in nature. It accounts for approximately 10 percent of water pollution in Montana.
- *Non-point source pollution* enters streams from dispersed areas, such as windblown sediment and runoff from roads or crop lands. It accounts for 90 percent of stream pollution. Non-point source pollution is usually associated with poorly planned land management activities.

Bioassessment

Biologists can assess water quality through bioassessment. During this process, they look for organisms from the stream that are sensitive to organic pollution or heavy metals. Organisms with low tolerance are called indicator species. Their presence indicates good water quality; their absence indicates degraded water quality.

Effects of Our Impact

- Can eliminate entire aquatic communities and make water unsafe for human use
- Increases temperature, which can biologically suppress stream systems
- Increases costs of water treatment, and reduces usefulness of pumps and ditches
- Affects water quality downstream because effects tend to accumulate throughout watershed

Lessening Our Impact

- Protect riparian areas—they filter non-point source pollution such as sediments and nutrients from runoff
- Adopt the Best Management Practices (BMPs) for agriculture, grazing, timber harvesting, and mining to minimize pollutants entering streams and rivers
- Obtain permits before starting any activity that may impact water quality

■ Floodplains

During a flood is not the time to figure out that you built your house in the floodplain, too close to a stream.

Floodplains are critical components of a healthy stream or river system. They provide room for flood waters to spread out and soak in to recharge groundwater and to reduce the flood's erosive energy. The fertile soil of floodplains enables abundant vegetation to grow and provides important wildlife habitat. If you armor your stream bank and raise its height to prevent flooding on your land, you are sending more erosive energy downstream to your neighbors.

PERMIT ALERT!

How We Impact Floodplains

- Poor agricultural and grazing practices
- Residential and commercial construction
- Protecting property by building dikes, levees, and retaining walls; by installing riprap; and by eliminating overflows into side channels

Effects of Our Impact

- Decreases ability of floodplain to disperse stream energy during flood flows, which:
  - —Increases energy of flood downstream
  - —Increases peak flood levels
  - —Increases bank and bed erosion on neighboring property
- Decreases vegetation cover, which may cause spring runoff to occur earlier and over a shorter period of time, and to produce higher peak flows
- Decreases ability of floodplain to recharge local aquifers, which:

Effects of Our Impact (continued)

  - —Decreases riparian vegetation
  - —Reduces channel flows in drier months
- Reduces aquifer volume
- Increases size and frequency of floods, causing more damage to property and stream channels
- Increases pumping costs

Lessening Our Impact

- Avoid construction in the floodplain
- Do not restrict floods from flowing into side channels without consulting stream management experts and obtaining a permit
- If construction activities must occur on floodplains, minimize disruption of the soils and vegetation
- Use agricultural methods that minimize impact on floodplain
- Establish greenbelts or stream protection corridors in floodplains

Channel Constrictions

A stream channel's cross section reflects the amount of water and sediment carried by the stream. If you change the stream's width by either narrowing or widening it, you alter its ability to transport water and sediment. Such changes cause other problems both upstream and downstream.

How We Impact Stream Channels

- Building bridges, berms, levees, roads, and railroads
- Cutting off side channels
- Installing culverts
- Placing debris or riprap along the banks

Effects of Our Impact

- Can increase the erosive energy at a particular location, which:
  - —Increases erosion of stream bed and banks
  - —Creates down-cutting (incision) of channel, which leads to lowering of local water tables and loss of riparian vegetation
- Creates low-energy backwater
  - —Increases filling of sediment
  - —Increases bank erosion
  - —Elevates flood flows

Lessening Our Impact

- Avoid confining channel
- Ensure that stream crossings, such as bridges and culverts, are large enough to pass flood flows
- Replace undersized stream crossings
- Stabilize erosive areas that add sediment to the water

■ Channel Widening

If your stream lacks pools and riffles, and seems unusually shallow, it may have an overly wide channel. Channels begin to widen if banks are trampled, vegetation is removed, or the channels become loaded with more sediment than they can carry. The sediment settles and begins to fill the channel. The same amount of water is now trying to flow through a smaller channel. As a result, the channel begins to widen.

How We Impact Channel Width

- Overgrazing and trampling by livestock
- Causing any degradation of the upstream banks, floodplains, or riparian areas
- Increasing amount of sediment either upstream or in immediate area
- Increasing flood flows by decreasing vegetation upstream
- Transferring water from one stream to another within the same watershed *(interbasin water transfer)*

Effects of Our Impact

- Increases bank erosion
- Increases need to treat drinking water
- Increases maintenance of irrigation pumps, diversions, and ditches
- Increases sediment loads, which encourages erosion and widening further downstream
- Decreases vegetation
- Decreases fish habitat by filling in pools and spawning areas and by warming water in summer and icing water in winter
- Eliminates riparian habitat

Lessening Our Impact

- Protect riparian vegetation
- Stabilize upstream erosion by replanting vegetation
- Manage riparian areas to prevent erosion

Channel Entrenchment

Entrenched channels are deep with high banks. Entrenched channels are most frequently found in highly erodible terrain. Changes in a channel's hydrology, sediment supply, or erosive energy can cause entrenchment, which is also called downcutting.

What Causes Entrenchment?

- Straightening or shortening a channel
- Decreasing sediment supply, such as by trapping sediments in upstream reservoirs
- Increasing channel's water supply

Effects of Entrenchment

- Lowers level of local water table to new stream elevation, which:
  - —Changes streamside plants and affects fish habitat and stream flow
  - —Impacts irrigation diversion and groundwater wells
- Eliminates access to the floodplain, which increases stream energy and bank erosion
- Reduces aesthetic values and recreational uses
- Reduces property value
- May increase water supply to a channel

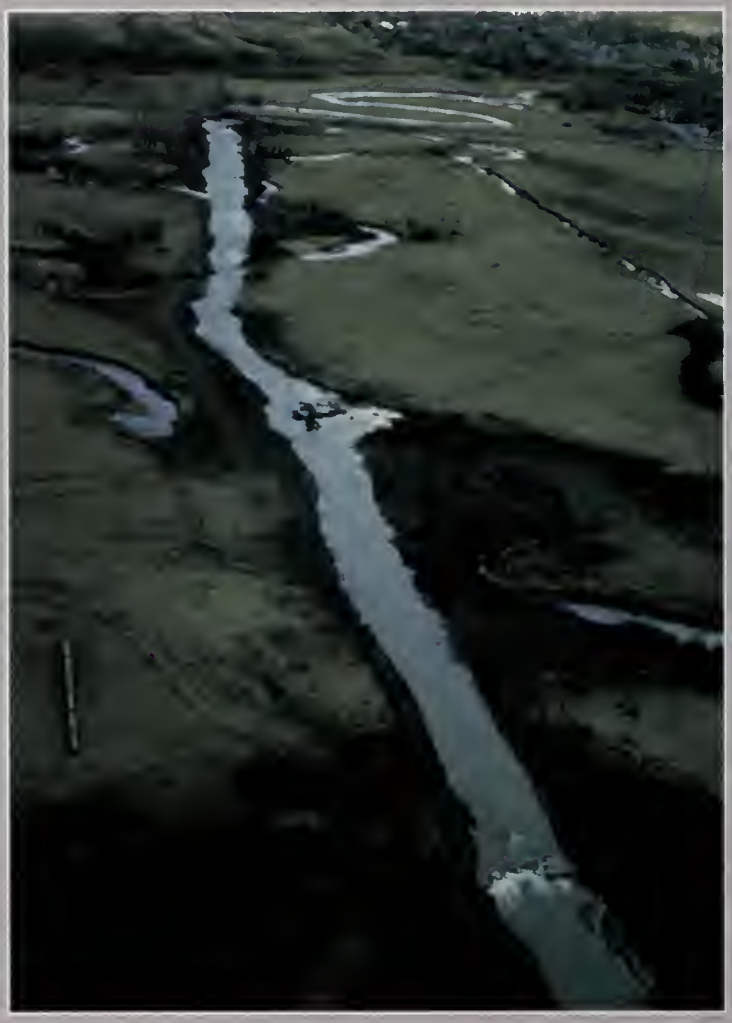
Lessening the Impact

- Prevent downcutting by protecting channel and banks from erosion, and by maintaining healthy vegetation along stream banks
- As soon as you notice downcutting, consult a stream management specialist for help
- Conduct a stream inventory or tour the upper watershed to identify potential problems

PERMIT ALERT!

Once a channel is deeply downcut, most stream managers consider the problem irreversible because few cost-effective solutions are available.

■ Channel Straightening



Streams that flow through steep, narrow valleys run relatively fast and straight. But once a stream moves into less steep and less confining land forms, it slows and begins to curve and meander. When the natural sinuosity of a stream is altered, the stream becomes steeper and its flow increases in energy. The stream reacts to these changes by making adjustments.

Effects of Our Impact

- Eliminates meanders and shortens stream length, which increases slope and reduces natural energy dissipation
- Increases velocity of water, which increases erosion downstream
- Increases flood intensity
  - —Speeds movement of peak flows
  - —Eliminates storage capacity of stream
- Decreases channel stability and increases channel migration as the channel attempts to come to a new equilibrium; this also increases problems upstream and downstream

Why Streams are Straightened

- To reduce the number of highway and railroad crossings
- To develop land more easily along streams
- To control overbank flows
- To protect property by eliminating channel migration

Lessening Our Impact

Stream managers rarely recommend straightening channels. Instead, they suggest these alternatives:

- Plan roads and other developments away from streamside areas
- Control upstream sediment sources to reduce downstream instability
- Stabilize channel banks

PERMIT ALERT! *If you think straightening is necessary, consult with stream management specialists and local water resource agencies to determine all of the impacts, upstream and downstream. Be aware that water resource agencies rarely approve channel straightening.*

If your stream is already straightened, consult a stream management specialist about restoring straightened sections to their original channel shape and pattern.

■ Streambed Disturbance

PERMIT ALERT!

In Montana's dry climate, streams usually lose water as gravity pulls water into the ground. The material making up the streambed controls the rate that water is lost from the stream. Fine sediments often seal a streambed and slow the loss of stream water. If heavy equipment or other activities disturb the fine sediments, water can seep into the aquifer at a much higher rate. This can cause an entire reach of the stream to go underground for a while.

How We Impact the Streambed Seal

- Operating heavy equipment in the stream channel
- Removing or disturbing channel bed materials

  Placer mining, for example, impacts streambed seals in both of these ways

Effects of Our Impact

- Increases water seepage into aquifer
- Reduces water available for in-stream use and downstream users
- Increases water temperature in the summer

Lessening Our Impact

- Operate heavy equipment in the stream channel only when absolutely necessary
- Use irrigation diversion alternatives that do not require operating heavy equipment in stream channels

■ Dewatering

In many watersheds within Montana, more water rights exist than water. Because of this over-appropriation of water, streams are dewatered on a regular basis by people exercising their water rights. Dewatering occurs every year but is especially intense during droughts.

Lessening Our Impact

- If possible, provide more water for in-stream flows
- Use irrigation water efficiently
- Use only legally appropriated water shares
- Try to manage reservoirs for water flows and fisheries
- Consider leasing water rights for in-stream use

Dam construction for water storage can improve water supplies, but it tends to alter the natural hydrologic cycle of high spring and low winter flows. Many species of wildlife, such as trout, are adapted to this natural cycle and time their reproduction to coincide with seasonal flows. Reservoir refilling or storage can result in streams being dewatered or flows greatly reduced in volume.

How We Impact Water Levels

- Over-appropriating water
- Building dams
- Storing water in reservoirs
- Transferring water from one basin to another

Changing water appropriations and legalizing in-stream water rights will require new legislation. You can improve water conservation, though, by changing irrigation practices. To learn more about reducing your consumption of irrigation water, consult local state agencies, including the Montana Department of Natural Resources and Conservation, and the U.S. Natural Resource Conservation Service.

Effects of Our Impact

- Disrupts natural life cycles of animals such as trout that depend on seasonal flows
- Decreases aquatic habitat by decreasing amount of water and vegetation
- Changes streamside vegetation from native riparian species to less-productive dryland species
- Increases water temperature
- Can alter natural cycle of high spring and low winter flows
- Can cause ice buildups if winter water flow is low; this causes ice jams that can scour stream banks, fish habitat, and adjacent properties

■ Methods & Costs of Streambank Alteration & Stabilization

The cost of bank stabilization measures varies. You can use this chart to compare costs, advantages, and disadvantages of different strategies.

Stabilization Measure	Advantages	Disadvantages	Costs *
Management Changes			
Implement grazing and agricultural practices that allow vegetation to recover.	Easiest to implement; natural recovery; diverse opportunities.	Results take time.	Low to moderate. Long-term increase in productivity may offset initial costs.
Revegetation			
Plant native shrubs; reintroduce native grasses and sedges.	Can be accomplished with hand labor; recovery of streamside habitat.	Labor/cost intensive; results take time; need riparian expertise; may need short-term change in land use.	Low to moderate, $.50-$10/foot. Costs reflect labor, availability and cost of plants.
Recontouring			
Increase streambank slope, then cover with erosion blankets and replant native vegetation.	High chance of success; recovery of riparian habitat.	Requires design and installation expertise, heavy equipment, and labor.	Moderate to high, $10-$100/foot, depending on bank height and intensity.
Riprap			
Rocks and boulders cover banks. Reduces vegetation; mitigate by adding logs and/or revegetating. ***You must consult with government agencies if considering riprap.***	Very stable banks.	Permanent loss of riparian habitat; may increase velocity and downstream erosion.	Moderate to high, $40-$60/foot, depending on local availability of rock.
Deflector Structures			
Jetties and barbs, usually constructed with natural materials, redirect water from unstable banks. Not recommended for everyday bank erosion problems. ***You must consult with government agencies if considering deflectors.***	When well designed, provides long-term stability.	Difficult to design and install; may cause new problems; unnatural appearance.	Moderate to high, $100-$1,000 per structure.
Revetments			
Organic version of riprap using bundles of brush, roots, or trees. ***Tires, cars, and other debris are prohibited as bank protection.***	Uses natural materials; easy to install.	Not effective in high-energy streams. Results take time.	Moderate, $5-$25/foot.
Channel Realignment			
To restore natural functions. ***Extreme measure; requires careful consideration.***	Quickest recovery to full potential; replaces all functions.	High cost; must use professional.	Moderate to high, $10-$70/foot.

** NOTE: These costs are used for comparison only and will vary depending on actual circumstance.*

A Final Word

Montanans recognize we have a rich natural resource in the state's streams. They provide water for us, for fish, for wildlife, and for plants. They also provide us, directly and indirectly, with jobs and recreation. We are also becoming aware of the value of riparian areas—the areas adjacent to streams—to the aquatic ecosystem.

This guide has introduced you to stream management by emphasizing the importance of understanding the resource and preventing problems. First, the guide discussed the various stream types in Montana and their adjacent components such as floodplains and riparian areas. Secondly, the guide focused on how to design a successful stream management strategy. Finally, the guide described specific problems, their causes, effects, and solutions.

As Chapter Three points out, the problems and solutions related to stream management can be relatively simple; they can also be quite complex. Use the resources listed in this guide to help you evaluate the streams under your care, to correct some of the problems, and to develop an effective stream management plan that will prevent future problems and protect this valuable resource.

Successful stream management will leave a legacy of healthy streams to future generations of Montanans.

Stream Words

Aquifer
Saturated zones of sand, gravel, fractured bedrock, or other material under the surface that has space between particles to hold water.

Bankfull width
Distance between average high water mark (HWM) on each side of stream. HWM is associated with slope or vegetation changes.

Channel
Stream bed.

Channel shape
Cross-section of a channel.

Dewatering
Removal of part or all of the water from streams or other bodies of water.

Ephemeral stream
Flows for brief periods of time as a result of snowmelt or rainstorms.

Floodplain
Land next to stream where water overflows during floods.

Gradient
Steepness or fall of slope.

Habitat
Food, water, shelter, and space that an animal requires.

Intermittent stream
Flows only certain times of the year with water from springs or runoff.

Lateral erosion
Where a stream erodes its banks and ultimately widens the stream channel.

Meandering
Highly sinuous stream, frequently winding back and forth across the valley floor.

Non-point source pollution Water pollutants originating from dispersed areas, such as erosion of disturbed soils.

Perennial stream
Flows all year.

Point bar
Deposit formed on the inside bend of a stream.

Point source pollution
Water pollutants originating from a known point, such as a discharge pipe.

Pool
Deeper portions of the stream channel caused by increased scouring on the outside of turns.

Reach
Length of stream with similar characteristics, selected for study or observation.

Revetment
Installation of materials such as trees, boards, etc., that dissipate or deflect the stream's energy and protect banks from lateral erosion.

Riffle
Shallow water with rapid current and flow broken by a substrate of gravel.

Riparian areas
Lands adjacent to streams and rivers where the vegetation is influenced by the greater availability of water.

Runoff
Movement of water over earth's surface.

Sinuosity
Amount of curvature in stream channel.

Watershed
Total land area that drains water to a given point; includes all area drained by one stream.

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Special Thanks To The Following People Who Allowed Their Material To Be Adapted For This Publication

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Montana Department of Environmental Quality 16, 17, 18, 27, 32

Montana Department of Fish, Wildlife, & Parks 1, 3, 4, 7, 24, 25, 28, back cover

Montana Department of Natural Resources & Conservation 22

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U.S. Forest Service, Northern Region 14, 15, 16, 23

Illustrations and Maps

Media Works, Bozeman, Montana Marcia Rueter Leritz, Graphic Artist line art sketches 2, 6-13, and airbrush color on sketches and maps

Montana State University Extension Forestry Program, line art sketches 2, 5, 6, 7, 8, 14-17, 20

Natural Resource Information System, Montana State Library, map 2

Montana Department of Natural Resources & Conservation, map 3

10,000 copies of this public document were published at an estimated cost of $1.24 per copy, for a total cost of $12,353 which includes $11,353 for printing and $1,000 for distribution.

To Request Additional Copies

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